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**PACKAGING PERFORMANCE TESTING
OF A
CORRUGATED FIBERBOARD BOX (10 IN. BY 10 IN. BY 10 IN.),
WITH ONE 9 IN. BY 9 IN. BY 9 IN. BOX, CONTAINING GRANULAR SOLID –
PACKING GROUP I (SURFACE and AIR MODES)**

Date: May 16, 2001

**AFPTEF PROJECT NUMBER: 01-101
POP TEST ID NUMBER: DODPOPHM/USA/DOD/AF69/DLA-F021**

Part 1. Report Cover

TEST REPORT APPLICABILITY STATEMENTS see section 2E:

Manhours: 20

Report Prepared by: _____

Susan J. Evans
Materials Engineer

A. Report Number: DODPOPHM/AF69/DLA-F021

B. Title: CORRUGATED FIBERBOARD BOX (10 IN. BY 10 IN. BY 10 IN.), WITH ONE 9 IN. BY 9 IN. BY 9 IN. BOX, CONTAINING GRANULAR SOLID – PACKING GROUP I (SURFACE and AIR MODES)

Responsible Individual: Michael Werneke

This report has been approved for publication and dated:

Approved by:

L.A. WOOD, Chief
Engineering Branch

MICHAEL WERNEKE, Chief
AF Packaging Technology and Engineering Facility

Performing Activity:

AF Packaging Technology and Engineering Facility
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AFPTEF Reference: 01-101

Date: May 16, 2001

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Requesting Organization: Defense Logistics Agency
DDC-J-3/J-4-0
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New Cumberland PA 17070

Requesting Organization's Reference(s):

(1) Letter 6 Dec 2000

Part 2. Data Sheet**A. Exterior Shipping Container****UN Type:** FIBERBOARD BOX**UN Code:** 4G**NSN:** 8115-00-190-4959**Specification Number(s):** ASTM D5118, Style RSC,/ASTM D4727, Type CF, Class WR, VAR SW, GR 350, V3c**Container Manufacturer:** Lynchburg Sheltered Industries, Lynchburg, VA 24501**Date of Manufacture:** 2001 (GSA advice code "2G" – newest stock)**Material:** Corrugated Fiberboard**Container Dimensions:** 10 in. x 10 in. x 10 in. ID**Closure (Type/Method):** ASTM D1974, Sealing Method B (7-Strip Method). Use 2-inch A-A- 1830 clear tape on closure, NSN 7510-00-266-6715.**Reinforcement (Type/Method):** ASTM D1972, Reinforcement Method 2B, using 1-inch wide filament reinforced tape (1 girthwise band for every 15 inches of box height/length).**Closure Specification Number(s):** A-A-1830 clear tape, 2-inch, NSN 7510-00-266-6715.**Reinforcement Specification Number(s):** A-A-1687 Fiber reinforced tape, 1-inch; NSN 7510-00-582-4772.**Absorbent Material Description:** Pieces of fiberboard were wedged on all 6 sides of the inner container as dunnage, to prevent shifting or free movement within the outer container.**Additional Description:** N/R**B. Inner Packaging of Combination Packaging****Type:** Corrugated fiberboard box**NSN:** 8115-00-079-8459**Specification Number(s):** ASTM D5118, Style RSC,/ASTM D4727, Type CF, Class DOM, VAR SW, GR 200**Manufacturer/Distributor:** GSA Advantage**Date of Manufacture:** 2001**Manufacturer's Number(s):** Unknown**Capacity, volume:** 729 cubic inches**Capacity, weight (as tested):** 95 lb**Dimensions:** 9 in. x 9 in. x 9 in.**Closure (Method/Type):** ASTM D1974, Sealing Method B (7-Strip Method). Use 2-inch A-A- 1830 clear tape on closure, NSN 7510-00-266-6715.**Secondary Closure (Method/Type):** N/A**Additional Description:** N/A**C. Actual Product:** Not Used**D. Test Product:** Used**Name:** Sand**United Nations Packing Group:** I**Physical State:** Solid (Granular)**Amount per outer container:** 1**Test Weight:** 45 lb (20.4 Kg) See Part 3.**Density/Specific Gravity:** 1.0**Drop Height:** 1.8 meters**Stacking Weight/Force Required:** 486 lb (220.4 Kg)**Stacking Weight/Force Used:** 490 lb (222.3 Kg)**Additional Description:**

1. Line the inner box with a 4-mil polyethylene bag, approximate size 24 in. x 24 in. to ensure the inner packaging will remain sift-proof.
2. Fill bag with granular solid up to a weight of 42.5 lb.

3. Twist bag and tape closed with fiber reinforced tape.
4. If the top of the closed bag leaves a gap of more than ½ in., fill top space with enough dunnage material, any type which is compatible with the granular solid, to create a tight pack when the inner container flaps are closed and sealed.
5. Close inner container IAW 2b.
6. Place inner box inside the outer 10 in. x 10 in. x 10 in. box using squares of fiberboard, on all 4 sides, as dunnage material between inner and outer boxes; use enough to tightly hold inner box in place and prevent shifting within the outer container.
7. Close outer container IAW 2a.

E. Test Applicability- See test results in parts 7

- (1) Tests documented herein are design qualification. It is the responsibility of the government shipper/certifier to fully verify design compliance and packaging material quality.
- (2) Drop testing performed herein was tested in accordance with DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This joint DoD policy document allows packaging to be drop tested more than once provided the packaging continues to pass the 49CFR 178.603 requirements. Questions about or clarification of this policy can be sought from the respective preparing activities of the regulation.
- (3) DoD contractor use of this test report or its resultant certifying mark only with the permission of the testing activity AND as specified in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A.
- (4) Pass/fail conclusions were based on the particular specimens, both inner and outer containers, and quantities of each submitted for test. Extrapolation to other manufacturers, applications, commodities, inner containers, container sizes, or lesser internal quantities is the responsibility of the packaging design agency or applicable higher headquarters and the limitations documented in 49CFR. Extrapolation of test results based on lesser than minimum UN/DOT required test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.
- (5) Reference to specification materials has been made based on one of the following methods: supplied by AFPTEF, provided by the requester, markings printed on, attached to or embossed on the packaging.
- (6) Testing performed in accordance with 49CFR 170-180, except as documented in this report.
- (7) Performance testing was undertaken and completed at the request of an agency responsible for management of the dangerous good(s). The completion of successful UN/DOT testing does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).
- (8) The DOT performance tests are intended to evaluate the performance of the entire packaging configuration's ability to prevent the release of contents during conditions normally incident to transportation. The criteria used to evaluate container system performance is whether the contents of the packaging are retained intact. The successful completion of the recommended tests does not ensure undamaged delivery.
- (9) Tests performed and documented, herein, in no way verify Government supplier's operations (included but not limited to: internal procedures, suppliers, or manufacturing processes) comply with the DOT's or international's regulations. The testing facility has no knowledge and assumes no knowledge, that specific material testing requirements (i.e. plastics - only allowed to use regrind from the same operation; specific vendor plastic formulations including quantity of carbon black, ultra-violet inhibitors or pigments, or production run's individual leakproofness tests) are or were performed by the manufacturer(s) listed herein, unless otherwise noted in the report.

Part 3 Introduction. Brief description of why specific tests were performed and rationale for the test product selected (if applicable).

The equivalent of Packing Group I testing was requested on the above stated configuration. This configuration is intended to be applicable to a large assortment of solid granular products contained in fiberboard boxes. For lesser volumes, variations to testing requirements can be found in 49 CFR, part 178.601(g).

Sand was used as the test solid as permitted by 49 CFR part 178.602(c). Use of an inner liner was necessary to prevent the sand from sifting between the box-flap edges and degrading the adherence of the sealing tape to the outer surface of the inner box. Without the inner liner, the inner container, and therefore the outer container (having the same structure), are not sift-proof for granular solids even before testing.

Each combination packaging was subjected to appropriate drop and vibration testing as prescribed by ASTM D4919. These tests are designed to simulate the shock and vibration a package configuration may encounter during conditions normally incident to transportation. The order of testing was drop test followed by the vibration test; the stacking test was performed on empty outer containers. The Cobb test was performed on samples taken from boxes not otherwise used in testing.

The use of one sample packaging configuration for multiple tests and drops is DoD policy as stated in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This option was exercised in this test as noted in Part 7.

Part 4. Tests Required/Performed. For container to pass all applicable tests must be performed and criteria listed herein must be met

NOTE: Packagings fabricated from fiberboard, paperboard, or paper, including composite containers with outer fiberboard containers, should be conditioned for a minimum 24 hours prior to testing. Standard conditions $23 \pm 3^{\circ}\text{C}$ ($73 \pm 4^{\circ}\text{F}$) and $50 \pm 2\%$ relative humidity apply.

A. Hydrostatic Pressure Test. 3 outer containers each individually tested for 5 minutes at 15 psig.

B. Stacking test. One test per outer container, 3 containers required. Compression by a top load is calculated to simulate a stack height of **3 meters**, maintained for 24 hours. **NOTE:** Where the contents of the test sample are non-dangerous liquids with relative density different from that of the liquid to be transported, the force shall be calculated in relation to the latter.

Static weight. Apply the calculated weights using a constant load evenly over the entire container.

$$M = \frac{m(3000-h)}{h}$$

where: m = container's gross mass (as shipped) in kilograms = 20.4 Kg

h = container's height in millimeters = 254 mm (effective height for container in stack)

M = constant load mass in kilograms = 220.4 Kg

or:
$$W = \frac{w(118-h)}{h}$$

where: w = container's gross weight (as shipped) in pounds = **45 lb**

h = container's height in inches = 10.0 in. (effective height for container in stack)

W = constant load weight in pounds = **486 lb**

Information - This test assumes similar weight containers stacked on top of the test sample. This may or may not be a valid assumption. This calculation also only provides a minimum weight. Consideration should be given to what will actually be experienced in the transportation cycle.

C. Drop test. 5 drops in order: flat on the top, bottom, long side, short side and top corner. The drop height shall be appropriate for the packaging group of the commodity. The container shall strike a target which shall be a rigid, non-resilient, flat, and horizontal surface. For other than flat drops, the center of gravity shall be vertically over the point of impact.

1. Solids and liquids, if the test is performed with the actual contents to be carried, or with another substance having essentially the same characteristics, or for liquids if the test is performed with water and the intended contents has density less than 1.2 g/cm^3 (specific gravity less than 1.2) the drop height shall be:

<u>Packing Group</u>	<u>Drop Height</u>
I	1.8m (70.9 in.)
II	1.2m (47.2 in.)
III	0.8m (31.5 in.)

2. Where the test sample doesn't contain the intended contents and its specific gravity is greater than 1.2, then obtain the required drop height in meters by calculating the following with product density (d):

<u>Packing Group</u>	<u>Drop Height</u>
I	(d) x 1.5m ((d) x 59.1 in.)
II	(d) x 1.0m ((d) x 39.4 in.)
III	(d) x 0.67m ((d) x 26.4 in.)

Round the drop height up to the first decimal.

D. Vibration Test (Domestic requirement). One test per container, total of three test specimens.

The test shall be performed for 1 hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material approximately **0.2 cm** (1/16 in.) thickness can be passed between the bottom of the package and the platform. The vibrating platform shall have a vertical double-amplitude (peak-to-peak) displacement of **2.54 cm** (1 in.). Perform tests in accordance to 49CFR 173 Subpart B, Appendix C and 49 CFR 178. **NOTE: If only one configuration sample is tested, test duration shall be 3 hours.**

E. Fiberboard (Water resistance test). One test per fiberboard specimen, total of six.

Strong, solid or double faced corrugated fiberboard (single or multi-walled) must be used, appropriate for the capacity and the intended use of the box. The water resistant outer surface must not increase in mass greater than **155 grams per meter² (0.0316 pounds per foot²)** after 30 minutes in accordance with International Standards Organization (ISO) 535 or Technical Association of the Pulp and Paper Industry (TAPPI) T441 or ASTM D3285. Three individual fiberboard specimens shall be exposed on the wire side and another three on the felt side.

Part 5. Criteria for Passing Tests. For container to pass all applicable tests must be performed and criteria listed herein must be met

A. Hydrostatic Pressure Test. Any leakage is cause for rejection.

B. Stacking test.

No test sample shall leak. Composite and combination containers shall not exhibit leakage of the filling substance from the inner receptacle or container. No test sample shall show deterioration which adversely affects transportation safety or show any distortion liable to reduce its strength, cause stacking instability, or cause damage to internal container components likely to reduce transportation safety.

C. Drop test.

Each packaging containing liquids shall be leakproof when internal and external pressures are equalized. Composite and combination containers shall not exhibit damage to the outer packaging likely to adversely affect transportation. In addition, the inner packaging shall not leak into the filling substance or lading.

D. Vibration test.

No rupture or leakage from any of the packages. No test specimen shall show any deterioration which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

E. Fiberboard (water resistance test).

The calculated water absorption of all samples shall be less than **155 g/m²**.

Part 6. Discussion and Test results. Narrative description of test results, including any rationale for variations. For container to pass all applicable tests must be performed and criteria listed herein must be met. All containers were conditioned/tested at standard conditions (23°C, 50% RH) unless otherwise noted.

A. Drop test. Pass

One combination packaging was dropped 1.8 meters onto the required four flat sides and a top corner. Inner containers were undamaged and there was no leakage of sand from either the interior or exterior boxes. Except for minor crushing of the impacted areas, no adverse results to the outer packaging were noted.

B. Stacking test. Pass

One empty closed outer containers were stacked with 490 lb for 72 hours (the extended test period was used as only one box was being tested). There was no damage to the box which could result in damage to the inner container, no crushing, nor stack instability. No other adverse results were noted.

C. Vibration test. Pass

The same combination package used in the drop tests was also used for the vibration test. One combination packaging was tested on an electro-hydraulic vibration table which was set at 1-inch vertical double amplitude (peak-to-peak) displacement, at a frequency such that the packaging was raised from the platform. The distance was measured using a 1/16-inch feeler gage. At the proper frequency the feeler gage could be passed between the bottom of the package and the table surface. There was no additional damage to the box or inner container and no leakage from the inner container. No adverse results were noted. This test procedure duration of 3 hours with one container was used as only one combination packaging was tested.

D. Water resistance (Cobb method) test. Pass

As required by 49 CFR part 178.516, the COBB Method Test for water absorptiveness was performed on specimens cut from the lot of boxes used in the drop stack and vibration tests.

3 Specimens were tested on the exterior side. Average **150 g/m²**.

Values : **147 g/m², 153 g/m², 150 g/m²**

3 Specimens were tested on the interior side. Average **149 g/m²**.

Values : **145 g/m², 154 g/m², 149 g/m²**

0 Specimens exceeded the 155 grams per square meter maximum limit.

Many factors may affect water absorption by corrugated fiberboard. Among these factors are abrasion, wear, flexure, improper storage, and age. These can greatly decrease the ability of the fiberboard to resist water absorption and result in higher than tested results. In addition, some fiberboard products are only treated on one side of the material, making the box construction method of increased importance. Usually, the water resistant side is the smooth side. The shipper must take appropriate steps to ensure that the box is correctly constructed with the water resistant side on the outside.

Part 7. Marking on Container.

The container specified herein passes the DoT and international regulatory requirements to the extent tested. Equivalent DoD built or grandfathered containers MAY also qualify for the following marking as directed by DoD policy documents.

UN **4G/X20.4/S/01**
 USA/DOD

Part 8. References

- A. 49CFR 170-180
- B. DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55A/MCO 4030.40A - Packaging of Hazardous Materials
- C. ISO 535/TAPPI T 441/ASTM 3285 - Determination of Water Absorption of Paper and Board (Cobb Method)
- D. ISO 3574 - Cold-reduced carbon steel sheet of commercial and drawing quantities.
- E. ASTM D999 - Methods for Vibration Testing of Shipping Containers.

Part 9. Distribution List

Commander
Defense Logistics Agency
DDC-J-3/J-4-0
ATTN: Linda McCarthy
2001 Mission Drive
New Cumberland PA 17070

AFMC LSO/LOP
Project Folder



Sand contained in inner liner, in 9 in. x 9 in. x 9 in. inner box.



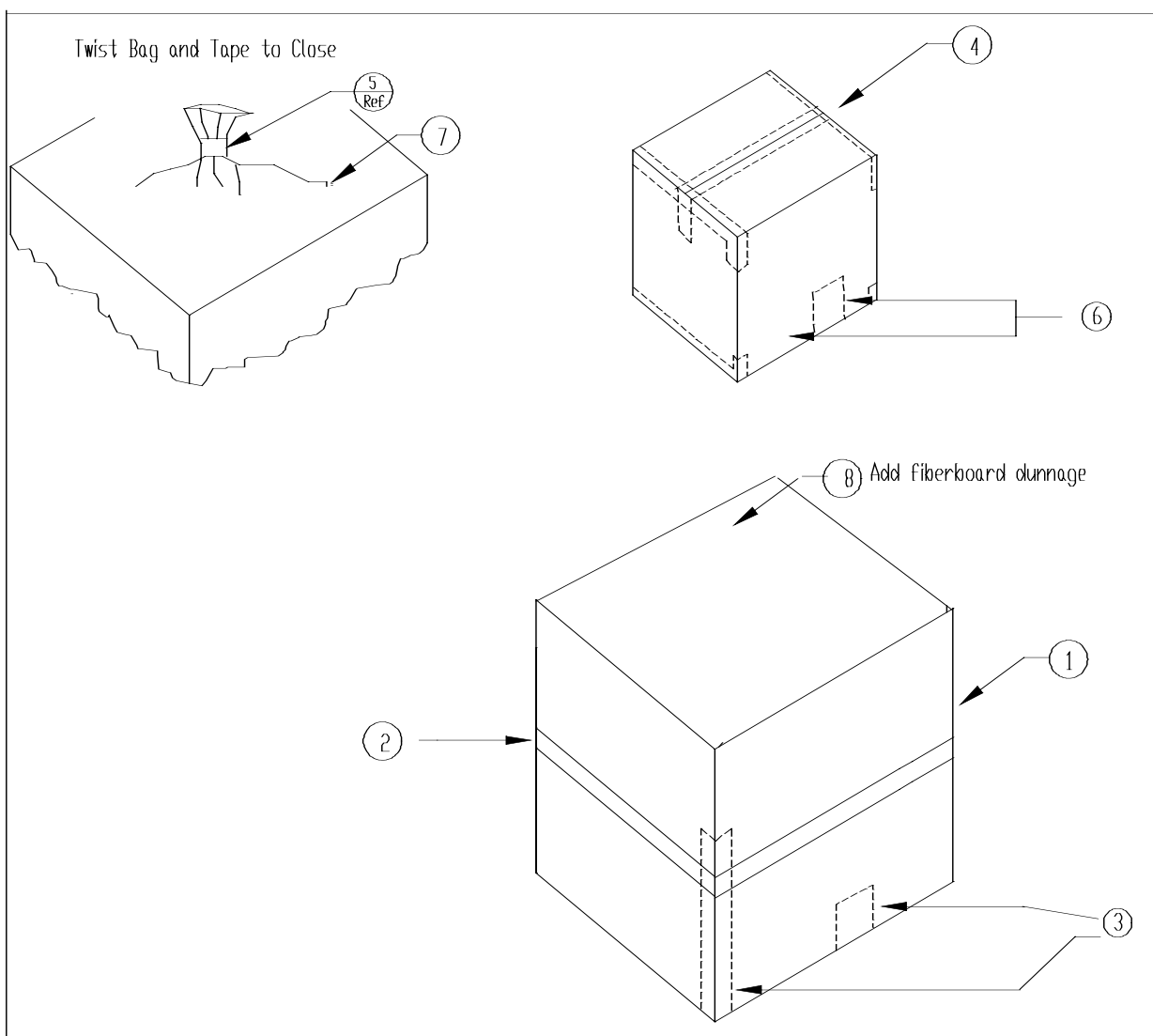
Closed inner liner containing sand, in 9 in. x 9 in. x 9 in. inner container.



Closed inner 9 in. x 9 in. x 9 in. box containing sand. Sealed with 2-inch clear tape.



Inner box of sand placed in outer 10 in. x 10 in. x 10 in. box, with squares of singlewall fiberboard inserted between walls of inner and outer boxes as dunnage. Two layers of fiberboard are beneath the inner box, two layers will be placed on top of the inner box before sealing of package. Outer container is reinforced with one strip of fiber reinforced 1-inch tape placed girthwise.



8	A/R	Use Fiberboard Squares as Dunnage Inserts	
7	1	Liner of Inner Box Filled with Sand to Box Depth	
6	A/R	2-Inch Clear Sealing Tape (Test Load)	
5	A/R	Fiber Tape Securing Twist Closure of Inner Liner	
4	1	Inner Container w/ Test Load, 9 in. x 9 in. x 9 in.	
3	A/R	2-Inch Clear Sealing Tape (Ext. Container)	
2	A/R	Girthwise Band Fiber-reinforced Tape	
1	1	Singlewall Corr. Fiberboard Box, 10 in. x 10 in. x 10 in.	
Item	Qty	Description	Notes
		AFPTF Air Force Packaging Technology and Engineering Facility	Note: Follow All Instructions in TR
File: DLAF021D.DWG			Dimensions in Inches
Dwg No: DLAF021D			Scale: NONE
Engineer: SJ Evans			PAGE 1 OF 1
		DATE: 16 May 01	